Injuries associated with fireworks in Victoria: an epidemiological overview

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Abstract

***Objectives*—To determine the epidemiological features of injuries associated with fireworks.**

***Design*—A retrospective study of reported cases.**

***Subjects*—Subjects were those who attended selected Victorian hospital emergency departments (n=17) and those admitted for firework related injuries (n=16).**

***Results*—The mean (SD) age of attenders at emergency department between January 1988 and June 1996, was 8.9 (6.2) years and most (88%) were under 18 years of age. Males accounted for 71% of the cases. The most common anatomical sites and types of injury were head (47%) and burns (88%), respectively. About 53% of the injuries were caused by firecrackers, the remainder by sparklers and penny bangers. Among those admitted to hospital between July 1987 and June 1996, the mean (SD) age was 22.9 (14.8) years and 50% were under 18 years of age. Males accounted for 87% of the cases. There was a significant difference in mean age between those admitted and not admitted to hospital, the former being significantly older.**

***Conclusions*—Although relatively rare, injuries from fireworks still occur in Victoria after legislative restrictions on their sale in 1985. Consequently, there is a potential risk for injuries among children, particularly from firecrackers. More enforcement of the regulations, education, and parental supervision are needed to prevent injuries from fireworks.**

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Keywords: fireworks; legislation; hospital admission; emergency department attendance

Fireworks are devices of ancient Chinese origin containing combustible chemicals that cause explosive or spectacular effects.[1] They are commonly used in both developed and developing countries to celebrate festive occasions related to tradition, religion, or culture. Examples include Independence Day in the United States, Guy Fawkes' night in Australia, Britain and New Zealand, Deewali in India, New Year in China and Italy, Prophet's birthday in Libya, and Hari Raya festival in Malaysia.

Although one gets pleasure from fireworks, they can often cause injuries to active users and bystanders. Such injuries are common worldwide and have been well documented.[2–15] The injuries can be serious and even life threatening. In most cases, they occur as a result of misuse and could be prevented with reasonable care.[11 16–18] Annually, 12 000 persons are treated in emergency departments for firework related injuries in the United States.[2] In Italy, one to eight deaths and over 1000 injuries have been reported annually.[3] Deaths from firework accidents are rare in Britain but each year between 30 to 40 children are admitted to hospital and 500–600 visit emergency departments.[19] Likewise, about 400 people are injured in the Netherlands each year and 80% of them are males between 12 to 20 years of age.[20] Most importantly, children suffer most from the private use of fireworks, whether as spectators or as active participants.[21] In an attempt to prevent eye injuries, the World Health Organisation has recommend legislation to regulate the manufacture and use of fireworks worldwide.[22]

In Victoria, the first restriction on the sale and use of fireworks was introduced in the Explosive Act 1960.[23] The Explosives (Fireworks Prohibition) order came into operation in 1982.[24] Subsequently, the Dangerous Goods Act 1985 was introduced.[25] Under section 54 of this Act,[26] some fireworks are not banned. These include Chinese firecrackers, sparklers, model rocket motors, toy pistol caps, and other novelty fireworks. However, the use of Chinese firecrackers and display fireworks are limited to licence holders who must be at least 21 years of age. Anyone who assists with restricted fireworks must also be at least 18 years old. The aims of this study were to document and describe the epidemiology of firework related injuries in Victoria, Australia, after restrictions on their sale and use in 1985.

Subjects and methods

Subjects were those who attended selected hospital emergency departments or who were admitted to hospitals for firework related injuries in Victoria, Australia.

Cases treated at emergency departments were identified from the Victorian Injury Surveillance System (VISS)[27] between January 1988 to June 1996 in urban and regional hospitals. VISS is a surveillance system of all types of injuries treated at hospital emergency departments and includes details of the circumstances and mechanisms of injury.

Cases admitted to hospitals were identified from the Victorian Inpatient Minimum Dataset (VIMD)[28] between July 1987 and June 1996. VIMD is a register of all hospital admissions throughout Victoria and uses International Classification of Diseases, ninth revision (ICD9) codes. In addition, the coroner's death database (July 1989 to June 1994),[29] the Victorian Emer-

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gency Minimum Dataset (VEMD), and the Extended La Trobe Valley Injury Surveillance (ELVIS) database[30] were searched. ELVIS is a general practitioner based injury data collection (1994–95) from the La Trobe Valley area. VEMD was implemented progressively from October 1995 in 24 Victorian public hospital emergency departments, and records details of injuries treated. This statewide database has replaced the VISS database described above. The search strategies included using the ICD9 E code for fireworks (923.0), factor code (product code), and text fields such as fireworks, firecracker, skyrockets, and sparklers.

Due to the small number of cases, body parts were grouped into head, trunk, upper extremities, and lower extremities. Injuries to face, neck, eyes, or forehead were treated as head injury.

DATA ANALYSIS

Data were analysed using SPSS for Windows (version 6.1).[31] Frequency distributions were calculated for each variable and descriptive statistics used to summarise the data. For continuous variables, mean (SD) was calculated. Categorical variables were summarised as percentages and assessed using χ^2 or Fisher's exact tests with Yates's correction. The mean age of those admitted and not admitted to hospitals were assessed by F test (analysis of variance).

Results

From VISS we found 14 cases that attended emergency departments between January 1988 and June 1996 and from VEMD three more cases were identified. Sixteen further cases admitted to hospitals between July 1987 and June 1996 were identified from VIMD. No cases were found in either the coronial or the ELVIS databases.

ATTENDANCE AT EMERGENCY DEPARTMENT

The mean (SD) age of the 17 cases who attended emergency departments and were not admitted was 8.9 (6.2) years and 94% were ⩽18 years of age. Children under 2 years, under 10 years, and those between 10 to 19 years accounted for 24%, 53%, and 47% respectively of the total. Seventy one per cent of the cases were males. The mode of injury was reported to be unintentional in 94%. The head was the most common site of injury (47%), followed by upper extremity (35%), trunk (24%), and lower extremity (18%). Five cases received eye injuries. Burns were the commonest type of injury (88%). Only one case was admitted; 47% were treated and sent home; and 47% were treated and referred to either outpatient clinics or casualty for follow up.

Public place and home were the two most common places of injury, accounting for 47% and 41% of the total injuries, respectively. Public places included public parks, roads, and playgrounds. Firecrackers, sparklers, and penny bangers were the three types of fireworks associated with injuries, accounting for 53%, 41%, and 6% of injuries, respectively.

Table 1 Demographic and injury characteristics of admitted and not admitted cases, Victoria, Australia; values are number (%) unless otherwise stated

Parameters	*Not admitted* (n=17)*	*Admitted (n=16)*	*Test*
Age (years)			
Mean (SD)	8.9 (6.2)	22.9 (14.8)	F=12.81 p=0.001
Gender			
Male	12 (71)	14 (88)	NS†
Female	5 (29)	2 (12)	
Injury			
Type			
Burn	15 (88)	5 (31)	χ^2=7.82
Open wound	1(6)	8 (50)	p=0.002
Anatomic site‡			
Head	8 (47)	8 (50)	NS†
Others	10 (77)	9 (56)	
Place			
Specified	16 (94)	5 (31)	χ^2=11.49
Not specified	1 (6)	11 (69)	p=0.0006

*Combined data from the VISS and VEMD.
†Not significant.
‡Some had more than one injury site and figure may exceed total.

HOSPITAL ADMISSION

The mean (SD) age of 16 admitted cases was 22.9 (14.8) years. Half were ⩽18 years of age with males accounting for 87% of the total. Interestingly, only 37% of cases were born in Australia. The mean (SD) length of hospital stay was 4.9 (5.8) days. The place of injury was known for only 31% of all cases. Injuries to the head, trunk, upper extremities, and lower extremities were 50%, 19%, 25%, and 13% respectively. Four cases received eye injuries. Fifty per cent had an open wound, 31% burns, 13% contusion or laceration, and one had an amputation of fingers. There was no fatality among the 16 admitted cases.

COMPARISON OF ADMITTED AND NON-ADMITTED CASES

Table 1 shows the demographic and injury characteristics of admitted and not admitted cases. The mean (SD) age of admitted cases was significantly older than those not admitted and there were more males among the admitted group, but the difference was not statistically significant. This age difference could also reflect potential bias towards paediatric cases in the hospitals providing emergency department data. Admitted cases had significantly more open wound injuries than non-admitted cases. There was no difference in the injury site affected between the two groups. Place of injury was significantly better specified for those not admitted than admitted cases, reflecting the advantages of a designated injury surveillance system.

Discussion

This study has described the characteristics of injuries associated with fireworks in Victoria using all available data. The main findings were that, despite legislation, injuries from fireworks still occur and that children are most affected. Hospitalised cases were significantly older than emergency department attenders. The reason for such age difference may relate to access to more dangerous fireworks by adolescents and adults and some sampling bias may also apply.

Males were injured more than females and this finding is consistent with previous reports.[2–6 8 10 11 14 15 32]

Although homes have been reported as the most common place for injuries to occur,[2 5 8] in this study it was the second most common place among emergency department attenders. Perhaps this was due to a small sample size. Nevertheless, it confirms that homes and public places are two important targets for any future intervention programs to minimise fireworks related injuries.

Most of the injuries among emergency department attenders were caused by firecrackers and sparklers. While sparklers are sold legally, it was impossible to assess from the data the legal status of the remaining fireworks. Generally, a law cannot totally prevent people from obtaining, making, or using fireworks. Injuries can result from both legal[11] and illegal fireworks.[4 9] Hence, to develop further countermeasures, the type of fireworks causing injuries should be thoroughly studied.

The reason why open wounds and burns were common among admitted and not admitted cases respectively is unclear. Perhaps the difference in the type of injury between the two groups reflects the fact that different types of fireworks were involved. A case series study on the circumstances of injury would help clarify this relationship. The association between misuse or mishandling and firework injuries is well documented.[11 16] Cunningham and Gaudry reported that injuries among patients treated for fireworks at Westmead Centre emergency department in New South Wales were caused by misuse behaviours, such as carrying live fireworks in pockets, or standing directly over the firework while igniting it.[16] In a case-control study, McFarland *et al* found that misuse or mishandling was the cause of 66% of the injuries.[11] Thus, self regulation can be an effective intervention.

In Victoria, deaths from fireworks are rare, as in other countries.[4 7] The Melbourne Fire Brigade recorded one death in 1987[33] and the National Injury Surveillance Unit recorded one death between 1979 to 1995.[34] These figures probably reflect the fact that people in Victoria have less access to the more dangerous types of fireworks after restrictions on their sale and use in 1985.

In the absence of any historical prelegislation data, the impact of legislation could not be evaluated. However, in the past, a few studies were conducted in the context of burns and accidents in both children and adults in Australia. MacLeod reported that, of 461 causes of adults burns between 1963 and 1967, four were caused by firecrackers.[35] Stitz indicated that of the 194 cases of burns in children at the Royal Brisbane hospital between 1967 and 1970, six were caused by fireworks.[36] Similarly, Savage and Leitch found that among children admitted to the Children's Burns Unit in Adelaide, 1% of the burns were caused by fireworks.[37] Blicavs and Savage reported very few firecracker injuries and admissions to the Adelaide Children's Hospital,[38] and Masterton *et al* indicated none among patients with flame burns admitted to the Alfred Hospital between 1973 and 1974.[39]

LIMITATIONS

There are several possible weaknesses in the current study. The emergency department data suffer from incompleteness, possible inaccuracies, and other biases. Injuries were identified from the VISS, VEMD, and the VIMD databases and the findings should be treated cautiously because the emergency department data are not representative of all injured cases. The structure of the VISS/VEMD and VIMD databases varied greatly, and data were not recorded in a similar format. It was difficult to combine the two and hence a separate analysis was undertaken. The VISS data originated from six participating hospitals and could not be generalised to all Victorian hospitals. On the other hand, the VIMD data were likely to be complete because all hospitals report admissions.

Implications for prevention

Based on the findings of this descriptive study, several recommendations can be made.

- Injuries related to fireworks should be closely monitored to better understand their epidemiology and thereby develop effective prevention strategies.
- Hospitals (private and public), general practitioners, and fire brigade should work together to improve the quality and reporting of fireworks related injuries. Such a working relationship will help to generate data that can be used to better estimate the incidence of fireworks related injuries and establish its public health importance in Victoria.
- To prevent unintentional injuries, public awareness of the dangers involved with using fireworks and methods of preventing injuries should be promoted. Primary and secondary school students and parents should be the prime target of future awareness programs.
- Future research should concentrate on identifying the types of fireworks causing injuries and their status under the current law. In addition, the risk factors associated with injuries and public compliance should be evaluated.

Finally, the findings of this study should generate a debate among the politicians, law enforcement authorities, educators, and parents. Victorian fireworks' law restricts the sale and use of certain fireworks. The law has been in place for over 10 years and an evaluation of the impact of this law is well overdue. Importantly, Victoria should protect existing mechanisms such as the existing strict legislation that appears to be effective in preventing these injuries. Any weakening of these legislative controls could increase access to fireworks and consequently, the risk of injury. Similar legislation should, therefore, be considered in other countries where fireworks are popular.

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1 Pearsall J, Trumble B, eds. *Oxford English reference dictionary*. Oxford: Oxford University Press, 1995.
2 Center for Disease Control and Prevention. Serious eye injuries associated with fireworks—United States, 1990–1994. *Morb Mortal Wkly Rep* 1995;**44**:449–52.
3 D'Argenio P, Cafaro L, Santonastasi F, *et al.* Capodanno Senza Danno: the effects of an intervention program on fireworks injuries in Naples. *Am J Public Health* 1996;**86**:84–6.
4 Smith GA, Knapp JF, Barnett TM, *et al*. The rockets' red glare, the bombs bursting in air: fireworks related injuries to children. *Pediatrics* 1996;**98**:1–9.
5 See LC, Lo SK. Epidemiology of fireworks injuries: the National Electronic Injury Surveillance System, 1980–1989. *Ann Emerg Med* 1994;**24**:46–50.
6 Sheller JP, Muchardt O, Jonsson B, *et al*. Burn injuries caused by fireworks: effect of prophylaxis. *Burns* 1995;**21**: 50–3.
7 Royal Society for the Prevention of Accidents. *Staying alive with water and leisure*. Birmingham, UK: RoSPA, summer 1997: 8–9.
8 Clarke JA, Langley JD. Firework related injury in New Zealand. *N Z Med J* 1994;**107**:423–5.
9 Center for Disease Control and Prevention. Fireworks-related injuries during the new year period, Naples, 1992–93. *MMWR Morb Mortal Wkly Rep* 1993;**42**:201–3.
10 Berger LR, Kalishman S, Rivara FP. Injuries from fireworks. *Pediatrics* 1985;**75**:877–82.
11 McFarland LV, Harris JR, Kobayashi JM, *et al*. Risk factors for fireworks-related injury in Washington State. *JAMA* 1984;**251**:3251–4.
12 Accident prevention—fireworks injuries. *Wkly Epidemiol Rec* 1992;**67**:54–5.
13 Mohan D, Varghese M. Fireworks cast a shadow on India's festival of lights. *World Health Forum* 1990;**11**:323–6.
14 Dhir SP, Shishko MN, Krewi A, *et al.* Ocular fireworks injuries in children. *J Pediatr Ophthalmol Strabismus* 1991;**28**: 354–5.
15 Isa AR, Moe H. Fireworks related injuries during Hari Raya festival in hospital Universiti Sains Malaysia, 1986 to 1990. *Med J Malaysia* 1991;**46**:333–7.
16 Cunningham P, Gaudry P. Misuse of fireworks [letter]. *Med J Aust* 1984;**15**:399.
17 Nicolai JPA, Van Twisk R. Hand injuries by fireworks. *Netherlands Journal of Surgery* 1988;**40**:160–2.
18 Origitano TC, Miller CJ, Izquierdo R, *et al.* Complex cranial base trauma resulting from recreational fireworks injury: cases reports and review of the literature. *Neurosurgery* 1992;**30**:570–6.
19 Avery JG, Jackson RH. Accidents with fireworks. *Children and their accidents*. London: Edward Arnold, 1993: 81–4.
20 Kon M. Firework injuries to the hand. *Ann Chir Main* 1991; **10**:443–7.
21 Hall JR. The latest toll from the private use of fireworks. *National Fire Protection Association Journal* 1996;**90**:79–82.
22 World Health Organisation. *Ocular trauma. Strategies for the prevention of blindness in national programmes. A primary health care approach*. 2nd Ed. Geneva: WHO, 1997: 74–80.
23 The Explosives Act 1960. Acts of Parliament 1960. No 6715. Victoria, Australia.
24 The Explosives (Fireworks Prohibition) order No 1/1982. Statutory Rules 1982. Volume 1, No 151. Victoria, Australia.
25 The Dangerous Goods Act 1985. Acts of Parliament, 1985. No 10189. Victoria, Australia.
26 The Dangerous Goods (Explosives) Regulations 1988. Statutory Rules 1988. Volume 2, No 272. Victoria, Australia.
27 The original Victorian Injury Surveillance System (VISS), January 1988 to June 1996. (Collected information from five Victorian Public Hospitals.) Available from: Accident Research Centre, Monash University, Clayton, Victoria 3168, Australia.
28 Hospital admissions. Victorian Inpatient Minimum Dataset (VIMD), July 1987 to June 1996. Available from: Accident Research Centre, Monash University, Clayton, Victoria 3168, Australia.
29 Coroner's court. Victorian Coroner's Facilitation System, July 1990 to June 1994. Available from: Accident Research Centre, Monash University, Clayton, Victoria 3168, Australia.
30 The Extended La Trobe Valley Injury Surveillance (ELVIS) database. A full twelve months general practitioners based injury data, 7 November 1994 to 6 November 1995. Available from: Accident Research Centre, Monash University, Clayton, Victoria 3168, Australia.
31 SPSS Inc. *SPSS for Windows (version 6.1)*. Chicago: SPSS Inc, 1989–94.
32 Center for Disease Control and Prevention. Fireworks related injuries—Marion County, Indiana, 1986–1991. *Morb Mortal Wkly Rep* 1992;**41**:451–4.
33 Victorian Metropolitan Fire Brigades Board. *Fire safety. Dangerous goods*. Victoria, Australia: Victorian Metropolitan Fire Brigades Board, January 1986 to July 1997.
34 The National Injury Surveillance Unit. Injury Surveillance Information System (ISIS), hospital separations and deaths databases. Available from: Australian Institute of Health and Welfare, National Injury Surveillance Unit, Research Centre for Injury Studies, School of Medicine, Flinders University of South Australia, Mark Oliphant Building, Laffer Drive, Bedford Park, Adelaide 5042, South Australia.
35 MacLeod A. Adult burns in Melbourne. A five year survey. *Med J Aust* 1970;**ii**:772–7.
36 Stitz RW. Burns in children. A three year survey. *Med J Aust* 1972;**i**:357–61.
37 Savage JP, Leitch IOW. Childhood burns: a sociological survey and inquiry into causation. *Med J Aust* 1972;**i**:1337–42.
38 Blicavs G, Savage JP. Childhood accidents. *Med J Aust* 1973;**i**:1039–45.
39 Masterton JP, Pressley TA, Ramsay GC. A survey of adults with flame burns at a Melbourne hospital. *Med J Aust* 1979;**i**:332–6.

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